FADS & FALLACIES

Debunking some old wives' tales about flying

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■■ It is said that truth is stranger than fiction and a thousand times more fascinating. The aeronautical corollary to this states that fiction often seems more logical than truth, a paradox that produces many widely accepted misconceptions.

This article deals with eight of these delusions and endeavors to displace fallacy with fact. But attacking someone's entrenched beliefs is like assaulting his or her spouse, religion or political persuasion. Nevertheless, truth must prevail.

Misconception Number One. *During a landing roll, a pilot needs to hold the nosewheel off the ground as long as possible. He should use nose-up trim for assistance.*

Logical? Yes. Correct? No, not if the plane is configured with a conventional elevator trim tab (as opposed to an adjustable stabilizer).

Although the use of nose-up trim makes it *easier* to maintain a nose-high attitude, positioning the tab in this manner actually reduces elevator effectiveness.

Assume, for example, that a pilot is about to land with a flat nosewheel tire or a retractable nosewheel that fails to extend. Since he needs to prevent the nosewheel from touching the ground until the last possible second, he applies as much nose-up trim after touchdown as is tolerable. Unwittingly, this pilot has defeated his purpose.

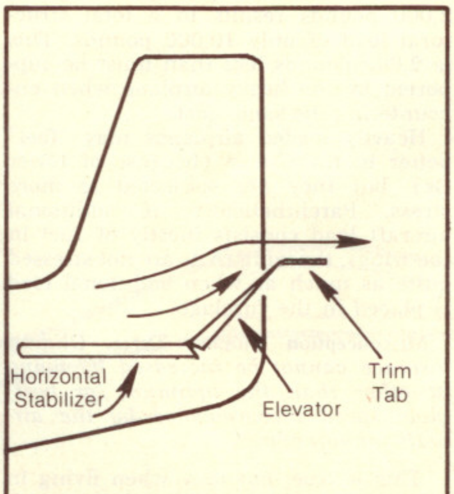

Figure 1a Nose-up Trim

Figure 1a is a sideview of a raised elevator with the trim tab deflected downward (nose-up trim). Notice that this positions the tab almost parallel to the relative wind, which reduces the "effective area" of the elevator and its ability to maintain a nose-high attitude at progressively slower speeds.

The most effective way to hold off the nosewheel requires precisely the opposite. After touchdown and with the nosewheel still off the ground, apply nose-*down* trim while holding the wheel aft. Pitch pressure does increase, but this is manageable at such a reduced airspeed.

Figure 1b shows that when nose-down trim is applied, the tab is deflected more vertically which increases the effective area and power of the elevator. This keeps the nosewheel off the ground at slower-than-usual airspeeds.

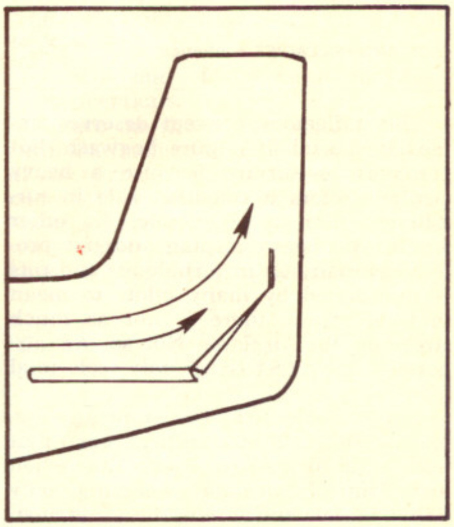

Figure 1b Nose-down Trim

Misconception Number Two. *When flying in turbulence, it is safer to fly a heavily loaded airplane than one that is loaded lightly.*

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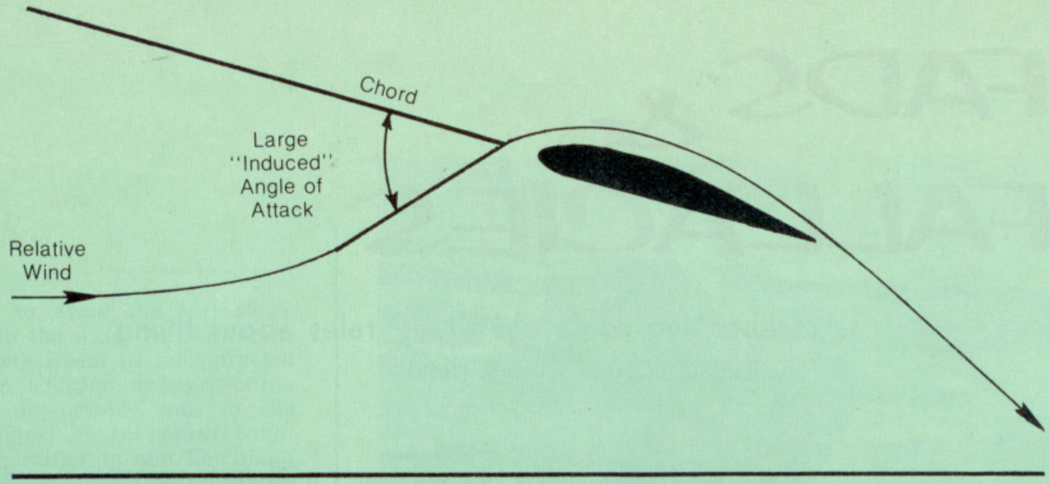

Figure 2a Large induced angle of attack creates considerable induced drag.

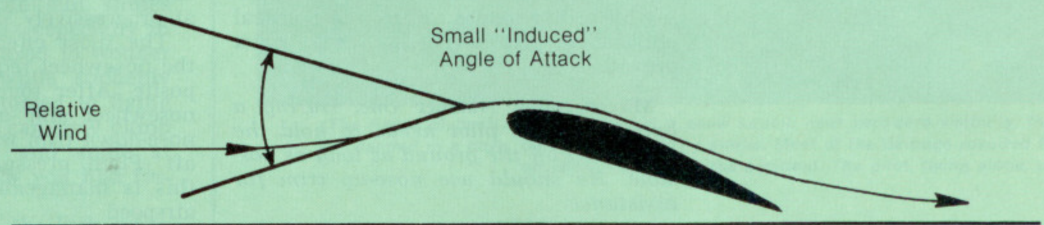

Figure 2b When induced angle of attack is decreased, induced drag decreases

This fallacious concept deserves immediate burial. It is pure hogwash, but manages to survive because a heavy airplane offers a smoother ride in turbulence than a light one. In other words, the heavy airplane doesn't produce as many Gs in turbulence and this is interpreted by many pilots to mean that, therefore, there is not as much stress on the airplane. Not so. An airplane doesn't feel Gs; it only feels total load.

For example, a 4,000-pound airplane encounters a 30-fps vertical gust that adds 2 Gs to the load factor. But when an identical airplane weighing only 2,000 pounds encounters the same gust, 4 Gs are added to its load factor. This is because the lighter airplane has 50% less inertia and is, therefore, twice as easily accelerated (or displaced) by the gust. As a result, the pilot in the light airplane "feels" more Gs than when flying the heavier craft. It seems logical, therefore, that more load is imposed on the lighter aircraft. T'aint so.

If the additional 2 Gs imposed by the gust upon the heavy aircraft are added to the 1-G load of normal flight, the total load factor acting upon the aircraft is, therefore, 3 Gs. Multiplying the load factor (3) by the gross weight (4,000) results in a total load of 12,000 pounds.

If the 4 Gs imposed by the gust on the 2,000-pound airplane are added to its normal 1-G load, then the total load factor acting upon the light aircraft is 5 Gs. Multiplying 5 Gs times 2,000 pounds results in a total structural load of only 10,000 pounds. This is 2,000 pounds less than must be supported by the heavy airplane when encountering the same gust.

Heavily loaded airplanes may "feel" better in turbulence (because of fewer Gs), but they are subjected to *more* stress. Parenthetically, if additional aircraft load consists mostly of fuel in the wings, the wing roots are not stressed quite as much as when additional load is placed in the fuselage.

Misconception Number Three. *Gliding distance cannot be increased by flying at other than the optimum (or best) glide speed recommended by the aircraft manufacturer.*

This is true, but only when flying in relatively calm air. When gliding with a tailwind or into a headwind (which is most of the time), airspeed can be adjusted to maximize gliding distance along the ground.

For example, assume that the pilot of a P-model Bonanza is descending—power off—at the recommended glide speed of 90 mph. Assume also that the aircraft is struggling against a 90-mph headwind. Groundspeed is obviously nil. To make *any* forward progress, glide speed must be increased to more than 90 mph. True, sink rate increases, but at least some headway is realized.

This exaggerated example points out that maximum gliding progress against a headwind requires more airspeed than when gliding in still air.

Conversely, when gliding with a tailwind, a slower airspeed should be used to reduce sink rate. This keeps the aircraft airborne longer which takes additional advantage of a tailwind and increases gliding range.

There are no precise rules that can be applied to all lightplanes. But for aircraft with normal glide speeds of 70-85 mph, glide range can be extended by using these guidelines: With tailwinds of 10, 20 and 30 mph, reduce indicated airspeed (IAS) by 4, 6 and 8 mph respectively.

Against headwinds, increase IAS by

50% of the headwind component.

Rules of thumb notwithstanding, decrease IAS slightly when gliding with a tailwind and increase IAS slightly when gliding into a headwind. Although this technique does not maximize glide distance, it is more efficient than ignoring wind altogether.

Misconception Number Four. *A lightly loaded airplane can glide farther than the same airplane loaded heavily.*

No way: the optimum glide ratio of an airplane is determined strictly by fixed aerodynamic characteristics. The minimum (or "flattest") glide angle occurs when an airplane is flown at that specific angle of attack where the lift-to-drag ratio is at a maximum, factors unaltered by variations in gross weight.

If two identical airplanes—one heavy and one light—are in side-by-side gliding flight and both are being flown at that specific angle of attack, then both aircraft will glide earthward along the same glide path. In other words, each aircraft will glide the same distance forward for each 1,000 feet of altitude lost.

There's one catch. Most airplanes do not have angle-of-attack indicators. So, the manufacturer provides an indicated airspeed that can be used to establish the proper angle of attack. The problem is that this airspeed is valid only for a specific aircraft weight, usually the maximum allowable gross weight.

To glide efficiently at lighter weights requires adjusting the airspeed slightly.

As a rule of thumb, decrease glide speed about 5% for each 10% decrease of maximum gross weight. For example, if a 3,000-pound airplane has a recommended glide speed of 80 mph, then that airplane should be glided at 76 mph (5% less than 80) when the aircraft weighs 2,700 pounds (10% less than 3,000). When the aircraft weighs 2,400 pounds, its best glide speed is 72 mph, etc.

Although the lighter aircraft doesn't go forward as rapidly, its sink rate is reduced proportionately which results in the same glide angle. This explains why sailplane pilots use ballast on cross-country races. The added weight necessitates an increased glide speed that allows faster completion of the flight without sacrificing glide performance.

Misconception Number Five. *Ground effect is caused by air being compressed between the wing and the ground.*

No again. Free-flowing, subsonic air is considered incompressible especially at velocities less than 200 mph.

When a wing is flown very near to the ground, it flies more efficiently than when more than 30 or 40 feet above the ground. This is not because of a "cushion of air" trapped between wing and ground, but because of a change in the airflow pattern about the wing.

Figure 2a shows a normal flow pattern. Notice the upwash ahead of the wing and the downwash of air behind the wing. This pattern also produces induced drag, the unavoidable and undesirable by-product of lift, predominant at large angles of attack.

In figure 2b, the aircraft is close to the ground; there is insufficient room beneath the wing for the vertical components of upwash and downwash to develop. As a result, the wing "senses" a smaller angle of attack and induced drag is reduced. This decrease in drag increases aircraft performance and is called "ground effect." It frequently is misinterpreted as a "cushion of air."

When in ground effect, airspeed dissipation during a landing flare takes longer and causes prolonged "floating." After liftoff, acceleration in ground effect is measurably greater than when above ground effect.

The effect is noticeable and helpful only when the wing is closer to the ground than a distance of half of its span. When a 36-foot wing, for example, is 18 feet above the ground, induced drag is reduced by 8%. When a wing is at a height equal to 20% of its span, induced drag is reduced by 29%. And when a wing is flown at a height equal to 10% of its span (4 feet for a 40-foot wing), induced drag is reduced by 48%.

For ground effect to be meaningful, the wing needs to be flown as close to the ground as possible.

Misconception Number Six. *Air flowing over a wing moves faster than air beneath the wing because it has farther to travel.*

This is one of the more humorous misconceptions.

Figure 3a shows the airflow pattern near the leading edge of a wing. A pair of air particles that had been travelling companions become separated at the leading edge. One is diverted over the wing while the other is destined to flow beneath the wing. Once divided, do

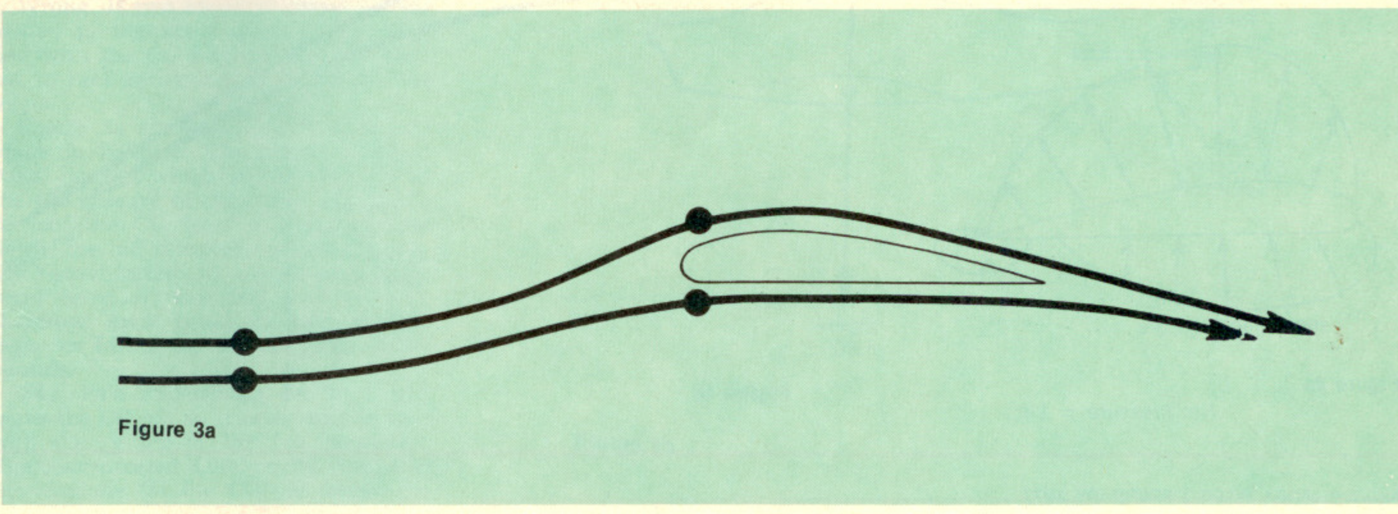

Figure 3a

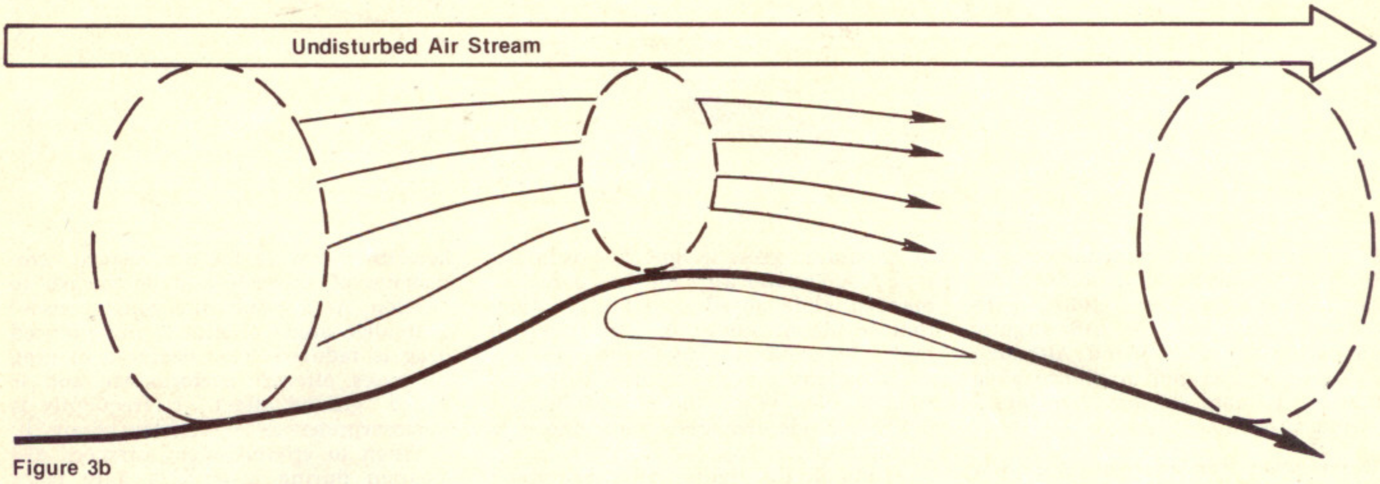

Figure 3b

these particles have any natural affinity that compels them to rendezvous at the trailing edge? Of course not, but this is the implication of saying that air above the wing accelerates because it has farther to travel (before reaching the trailing edge) than air beneath the wing. This is unadulterated fiction. Air particles are not psychic and have no way of knowing how far they must travel to reach the trailing edge.

Once separated at the leading edge, the air particles in question will never again meet unless by coincidence while being stirred in the belly of an equatorial thunderstorm.

Figure 3b illustrates why air flowing over the wing is accelerated. Wing camber (curvature) and angle of attack form the bottom half of a venturi "tube."

Every student of physics or basic aerodynamics knows that when a fluid (air is a fluid) enters such a constriction, it must accelerate to maintain a constant flow of mass through the "tube." This is because subsonic, free-flowing air is incompressible and resists being compacted in the throat of a venturi.

This is the same reason that water flows faster from the constricted nozzle of a garden hose than it does when the nozzle is open fully.

Misconception Number Seven. *Wing lift is created by reduced pressure above the wing (combined with high pressure beneath the wing)*—or—*it is the reaction to the downwash of air beneath and behind the wing.*

Both statements are not only correct, they're interdependent. The misconception is that many pilots believe that lift is attributable to only one of these reasons. One school of thought argues that lift is explained only by Bernoulli's

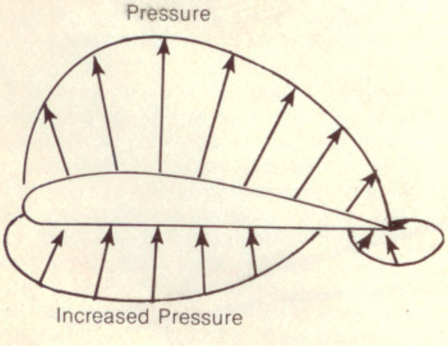

Figure 4a

Net Pressure = Lift

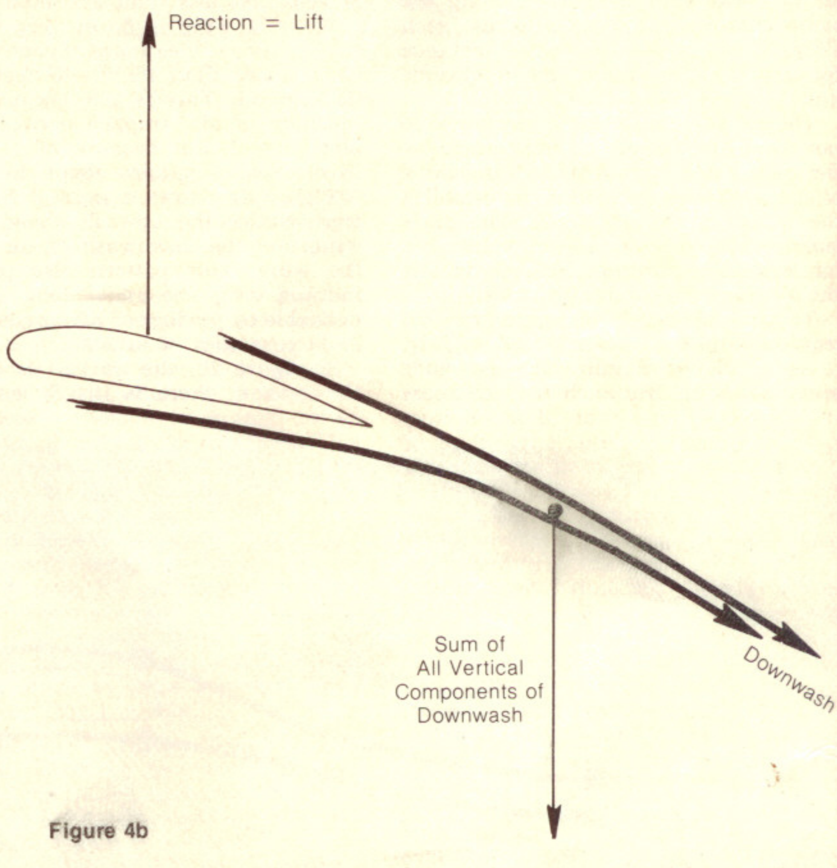

Figure 4b

principle while their opponents claim that lift is simply the reaction to the large mass of air accelerated downward from beneath and behind the wing.

Neither theory is entirely correct because the creation of lift requires both phenomena.

Figure 4a shows the pressure distribution about a typical airfoil at a given angle of attack. The arrows (vectors) represent the magnitude and direction of the pressure distribution about a wing (reduced pressure above and increased pressure below). If the vertical components of all these forces are added, the sum exactly equals the total lift generated by the wing.

Figure 4b shows the downward velocity imparted to the airflow by a wing (downwash). When carefully measured, it can be found that the sum of all vertical downwash components also is exactly equal to the lift of the wing.

The salient point is that the pressure gradient resulting from the application of Bernoulli's principal *cannot exist* without creating downwash and downwash *cannot* be generated without the required pressure distribution. Each is dependent upon the other.

The error of so many is the attempt to explain lift with only one of the pressure or the downwash theory.

Lift is not an "either-or" phenomenon and is totally dependent on both factors whether being created by a kite, a parachute, a wing or a barn door.

Misconception Number Eight. *An airplane with an aft CG loading (tail heavy) cannot fly as fast as the same airplane with a forward CG loading (nose heavy).*

This erroneous concept seems logical because a pilot envisions an aft-loaded airplane "mushing" through the sky in a tail-low attitude. "Obviously," he reasons, "this airplane can't fly as fast as when loaded to a more forward CG."

Wrong. If two identical airplanes are loaded to the same gross weight, the one with the CG farthest aft flies fastest, a fact recognized by most racing pilots.

Figure 5a shows a typical light airplane in balance. The aircraft weighs 3,000 pounds which is concentrated at the CG forward of the center of lift. To prevent the CG from pulling the nose down, the tail is called upon to balance the "teeter-totter" by exerting a downward force of, say, 200 pounds. Lift, therefore, must equal the sum of both negative forces or, in this case, 3,200 pounds.

Now let's redistribute the load and move the CG aft so it is directly in line with the center of lift (or pressure). The concentrated 3,000-pound weight of the airplane (at the CG) no longer exerts a nose-down moment. As a result, the tail is not required to create a negative, balancing force. Now the wing needs to create only 3,000 pounds of lift, 200 pounds less than when the CG was farther forward.

Since the wing doesn't have to produce as much lift when the CG is aft, it can fly at a smaller angle of attack which means less drag and, therefore, more speed. □

Editor's note. After submitting this article, Barry Schiff advised us that to avoid the anticipated avalanche of rebuttals, he is embarking on an extended flight in his Aeronca "Champ" in his continuing pursuit of truth.

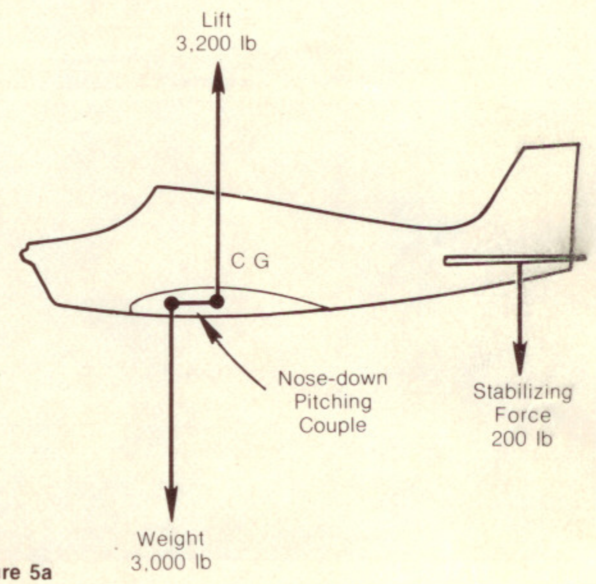

Figure 5a

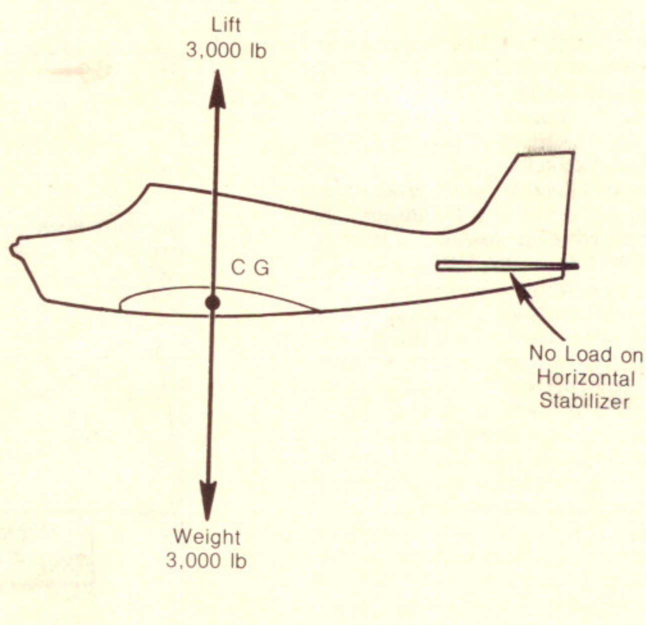

Figure 5b